Nanotechnology at RTI International
Research Triangle Park, North Carolina

Global Centers for Aerosol & Nanomaterial Engineering

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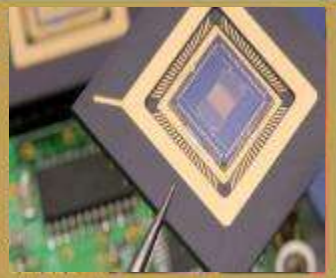
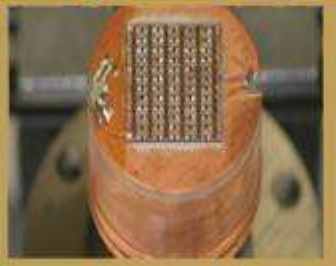
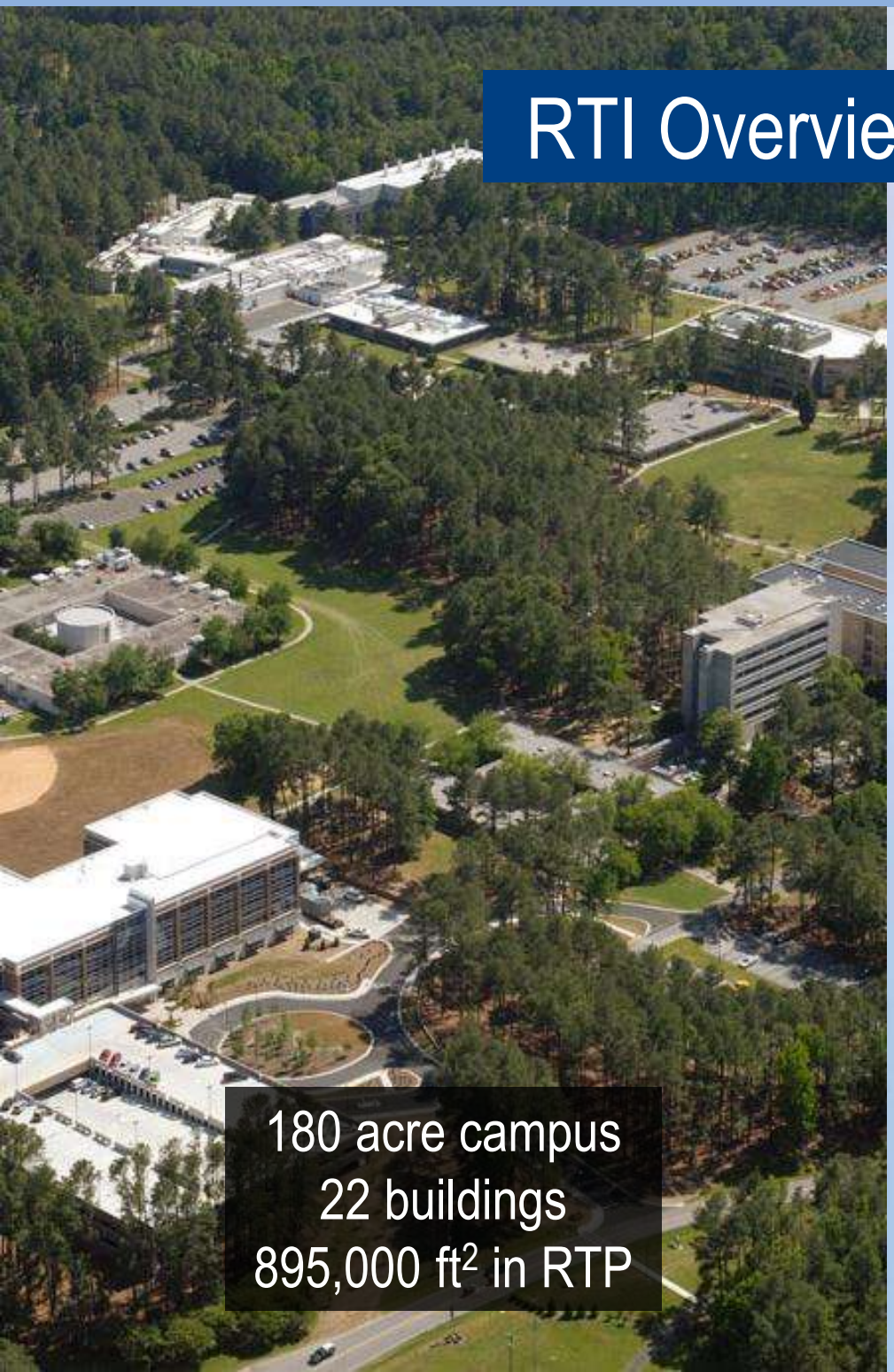




RTI Overview



- Independent, not-for-profit research and development organization
- Founded in 1958 through a partnership between business leaders, state government, and area universities
- **Mission: to improve the human condition by turning knowledge into practice**
- One of the world's leading research institutes, with revenues >$750MM and 13% average annual growth over the last 10 years.
- >4,200 professionals in >40 countries

Engineering & Technology Unit R&D

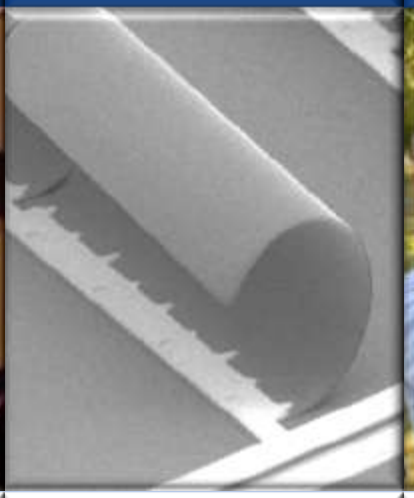
Energy

- Process engineering
- Biomass and biofuels
- Advanced gasification
- Solar fuels
- Carbon capture
- Photovoltaics
- Energy-efficient building materials

Materials

- **Nano-enabled materials & composites**
- Catalyst and sorbent technologies
- **Advanced membranes**
- **Advanced materials**
- **Cement and concrete**

Electronics



- Microsystem integration and packaging
- Thermoelectrics
- MEMS devices
- Flexible electronics
- **Sensors and integrated systems**

Environment

- Aerosol & exposure monitoring
- Environmental sensors and monitoring
- Ecotoxicology
- Aerosol physics and chemistry

Health

- **Nanotoxicology**
- Aerosol therapeutics
- **Particle-based vaccines**
- **Medical devices & biosensors**
- **Occupational medicine & industrial hygiene**

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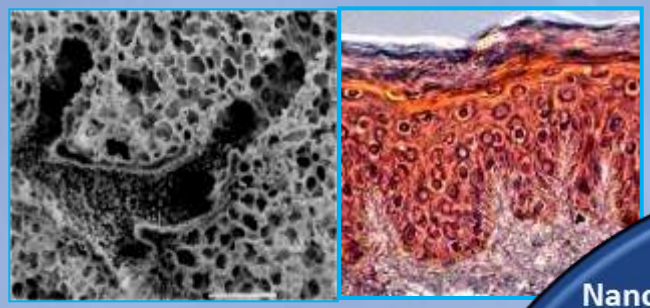
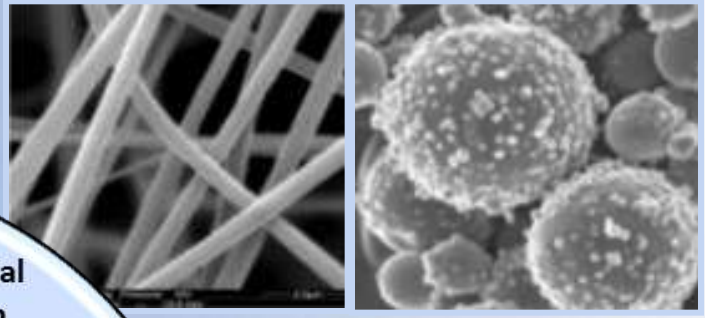
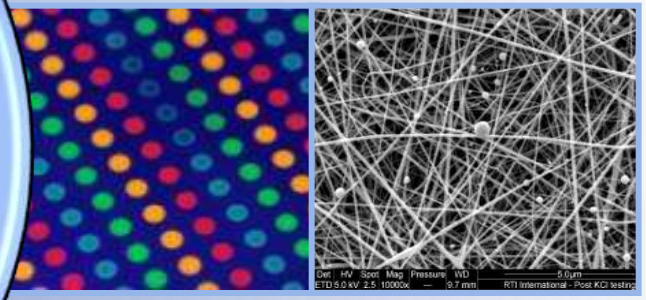
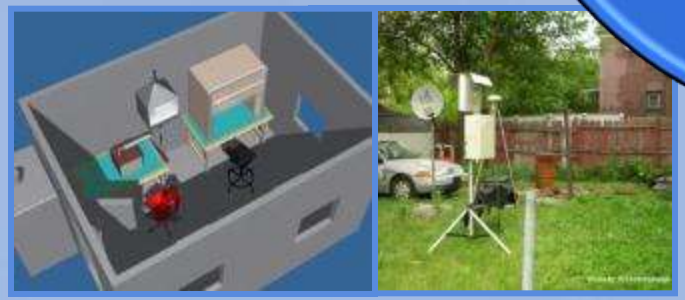
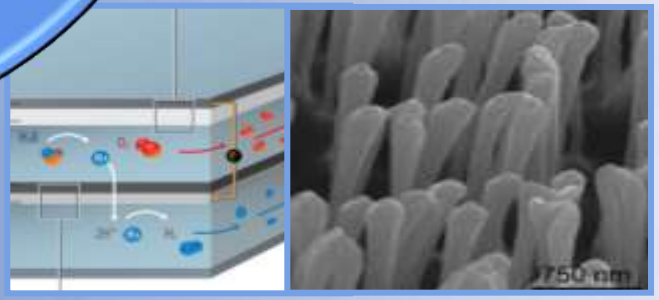
Our Center's Overview

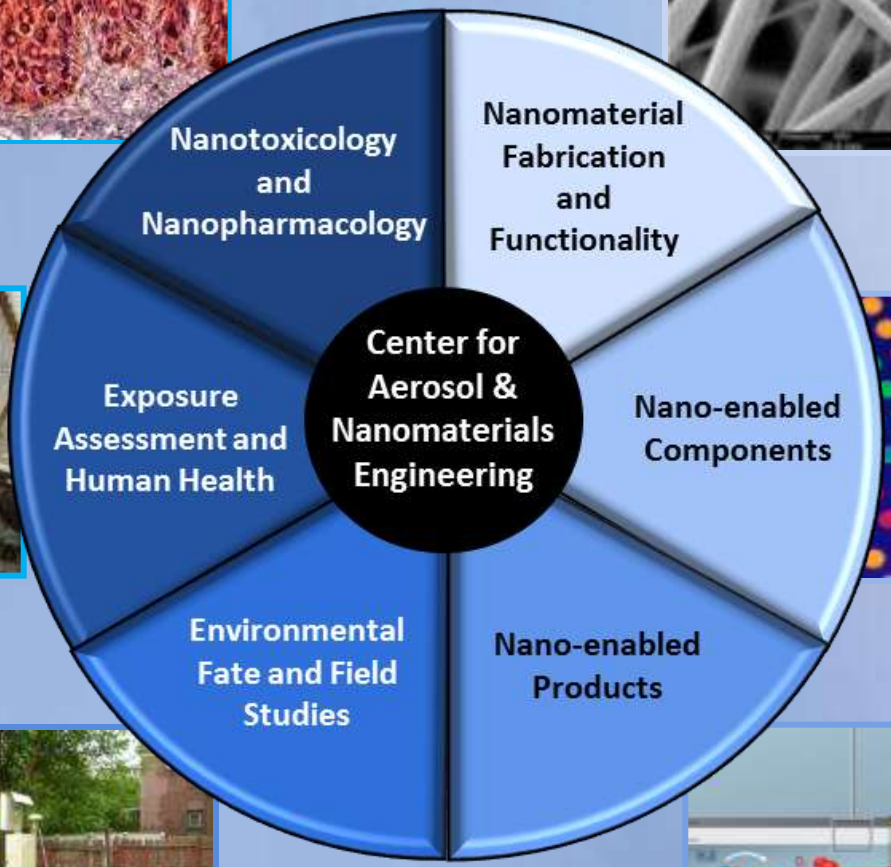








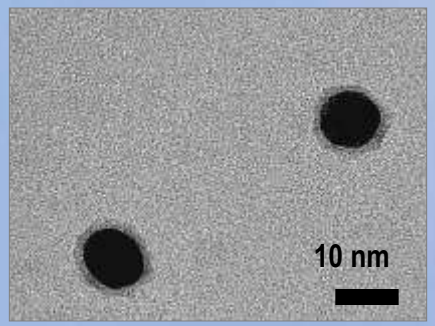


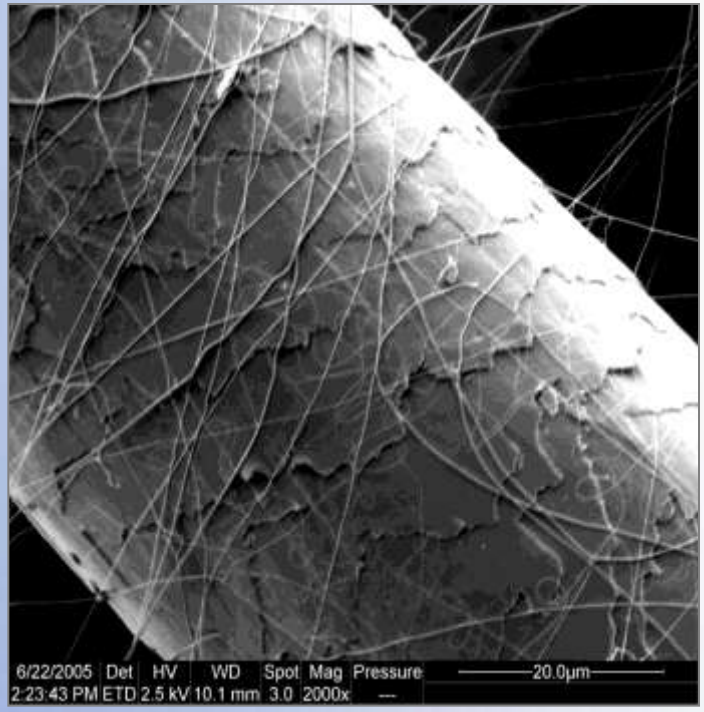


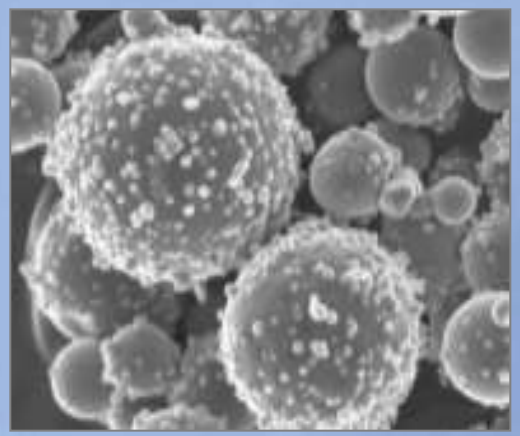
Nanomaterial Fabrication and Characterization

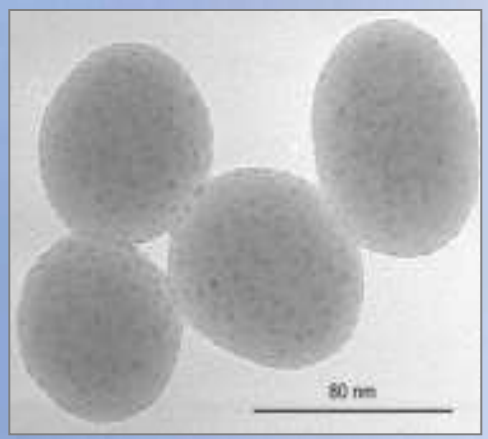
Through chemistry and process engineering, the characteristics of nanomaterials can be precisely tuned to enable functional benefits

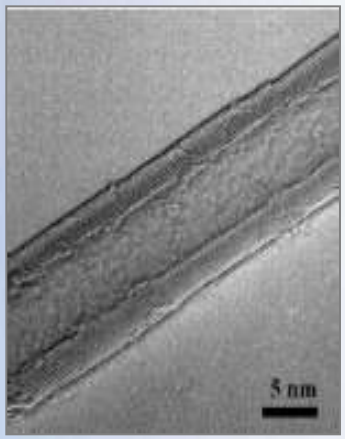
- Particle Size and Surface Area
- Composition
- Purity
- Size Distribution
- Surface Chemistry
- Charge
- Morphology











Characterization is performed before, during, and after any experiment

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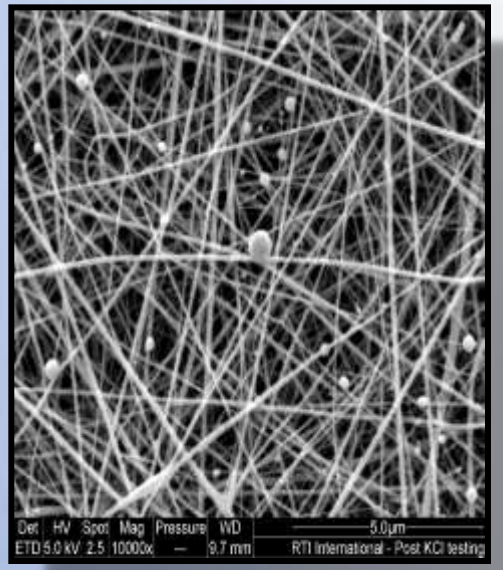
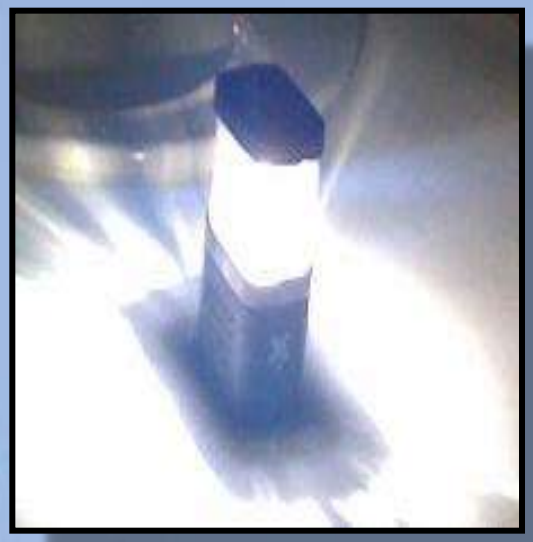
Nano-enabled Components

Air filters

- High filtration efficiency and reduced pressure drop enables lower breathing resistance and reduced energy costs
- Functionalization yields benefits in mechanical strength and chemical resistance





Nanofiber Lighting Improvement Technology (NLITe™)

- Control of material structures enables the fabrication of efficient (> 97%), diffuse reflectors
- 20% more light, 0% more energy
- Colors ranging from warm white to cool white through use of advanced tunable device structures with quantum efficiencies > 75%

R&D 2011 100

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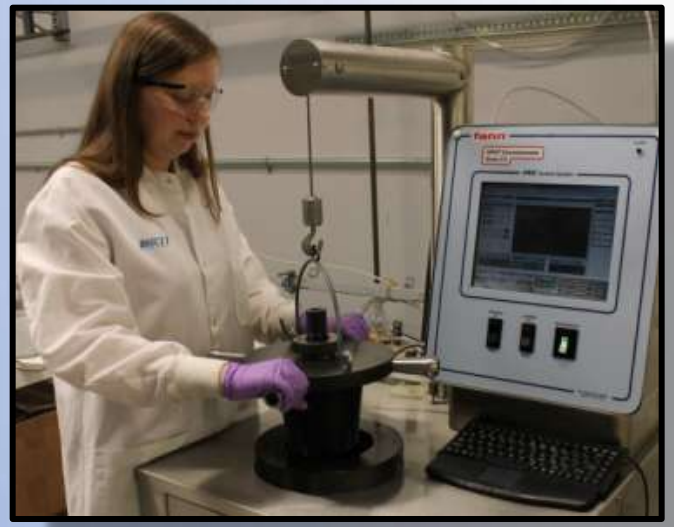
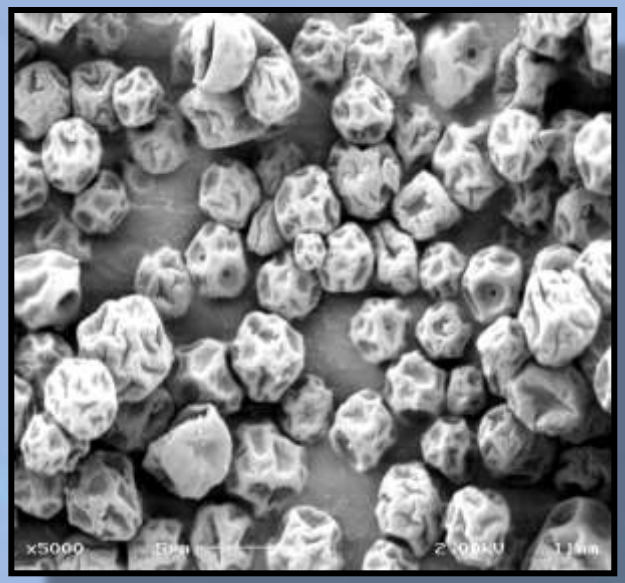
Advanced Materials Ranging Infrastructure to Health

A suite of capabilities to address unmet needs in cementitious materials

- **Novel cement formulations for subsurface applications**
- Control of cement setting properties
- High strength concrete
- Reduction of greenhouse gas emissions





Inhaled particles for treatment and prevention

- **Novel particle & biomolecule formulations for specific diseases**
- Tuberculosis is one of leading causes of death from an infectious disease
- In-house capability to test formulation for safety and efficacy

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Nanotechnology Standards

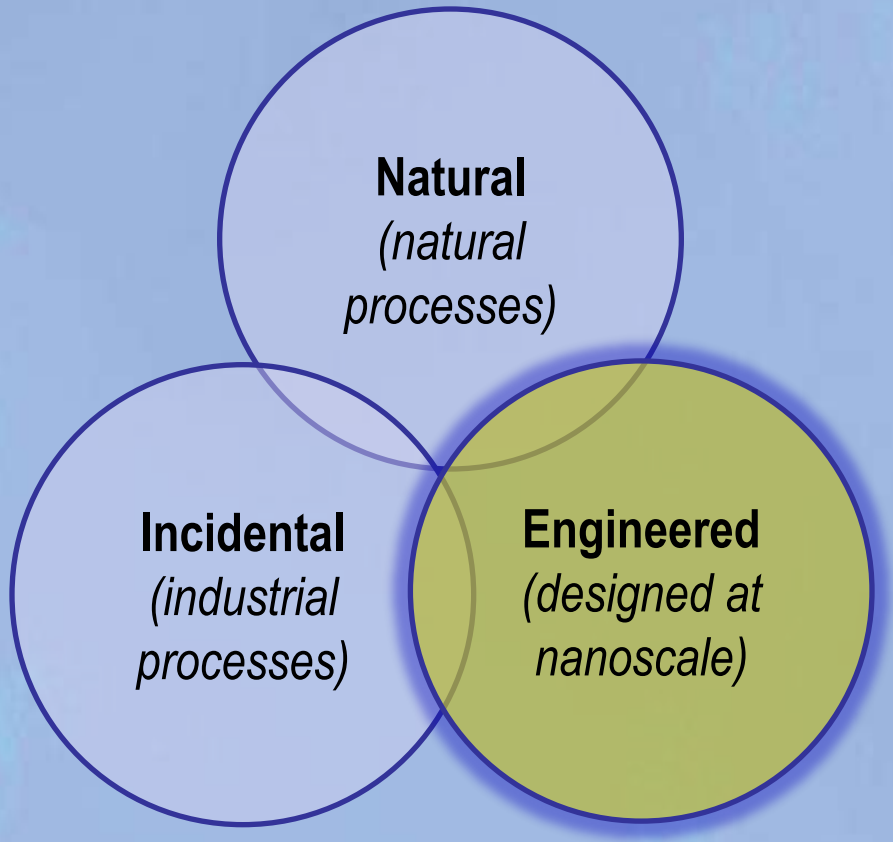
- RTI has leadership roles with international standards organizations dealing with standards for nanomaterials (ISO) and nano-enabled devices (IEC)
- Scientists and engineers also sit on a variety of Scientific Advisory Boards for government agencies (EPA FIFRA) and university centers (NC State's ASSIST)

Examples of standards subject matter:

- Nomenclature
- Health, safety, and the environment
- Materials specifications
- Quantum efficiency measurement methods

Science-based EHS for Engineered Nanomaterials

- The successful commercialization of nanomaterials and nano-enabled products requires a proactive approach to managing risk and regulations
- A strategy to specifically target the environmental, health and safety aspects of engineered nanomaterials



- A **comprehensive package** of ecological and biological safety data for nanomaterials and nano-enabled products;
- **Data interpretation** in the context of a specific product or product category; and
- **Recommendation** with respect to the science, business and regulatory path forward.

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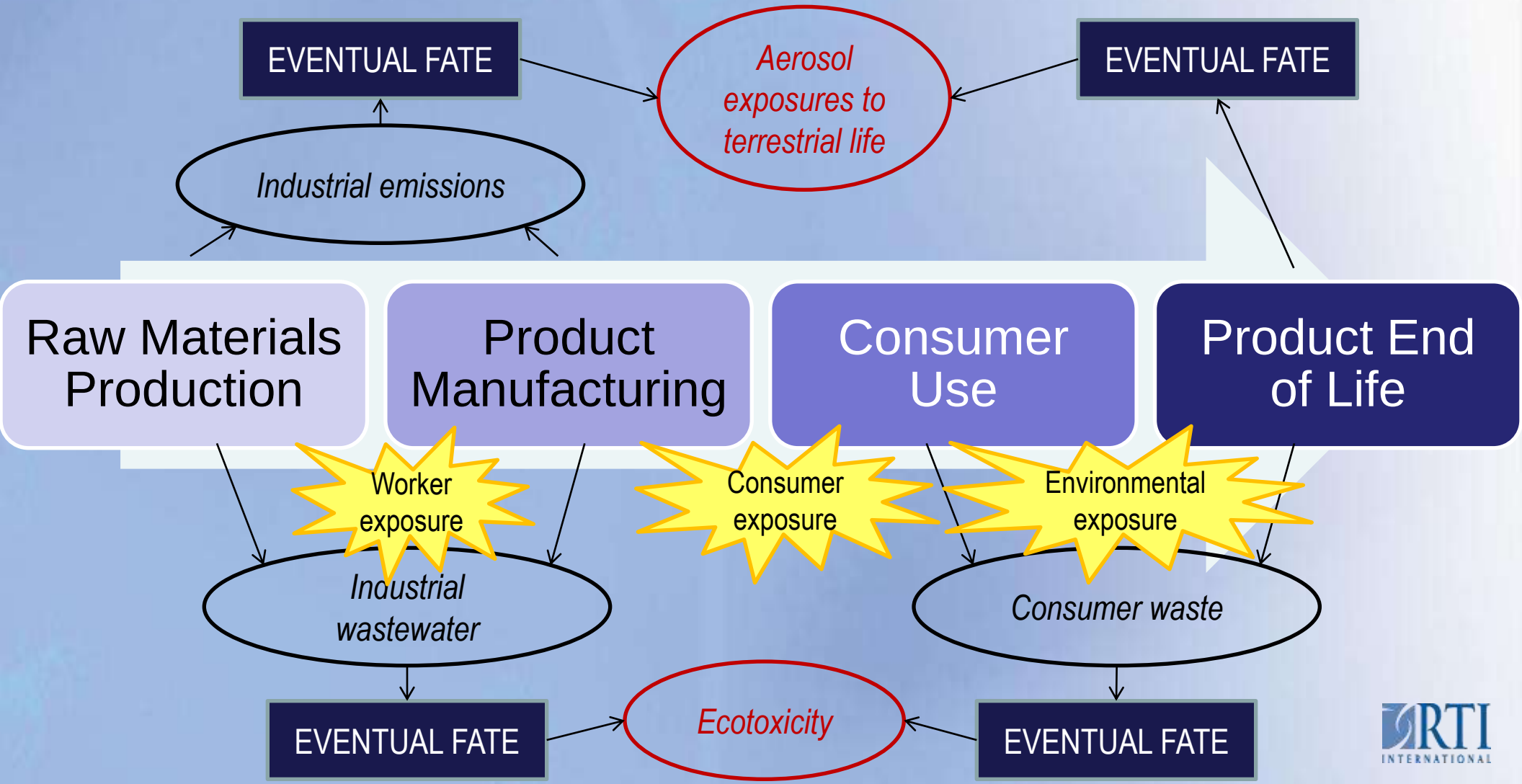
Nano-enabled Product Life Cycle

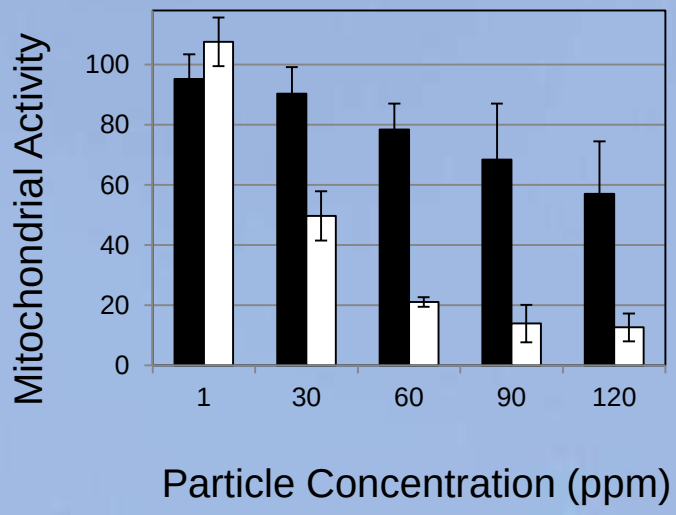
A *Product Life Cycle Approach* integrates product development with manufacturing and consumer exposure, enabling an opportunity to elucidate the human and environmental impacts of a technology



Nanotoxicology and Nanopharmacology

Observed Toxicities & Modes of Action

Elucidating the structure-activity relationships of advanced materials can provide valuable insights into understanding the potential applications and implications of nanotechnology

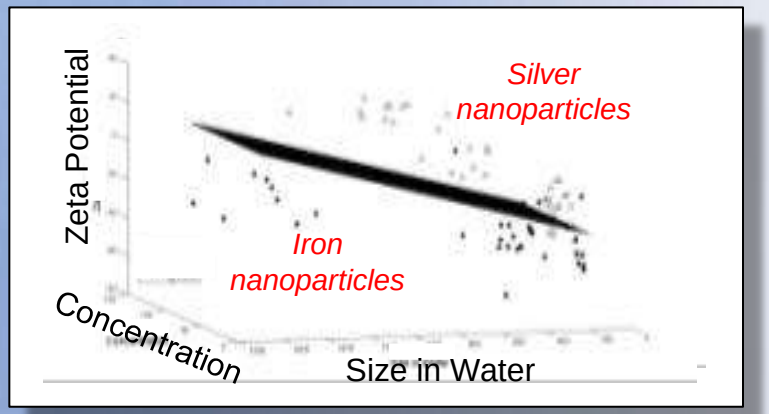


Building Quantitative Models

Ultimately, data is combined to conduct a nanoparticle-specific risk assessment, to build predictive mathematical models, and to compile a cost-benefit analysis

Effect = f(combination of NP features)

*Where **Effect** represents damage/death and the function **f** is either a regression model or a classifier approach based on combinations of NP features*



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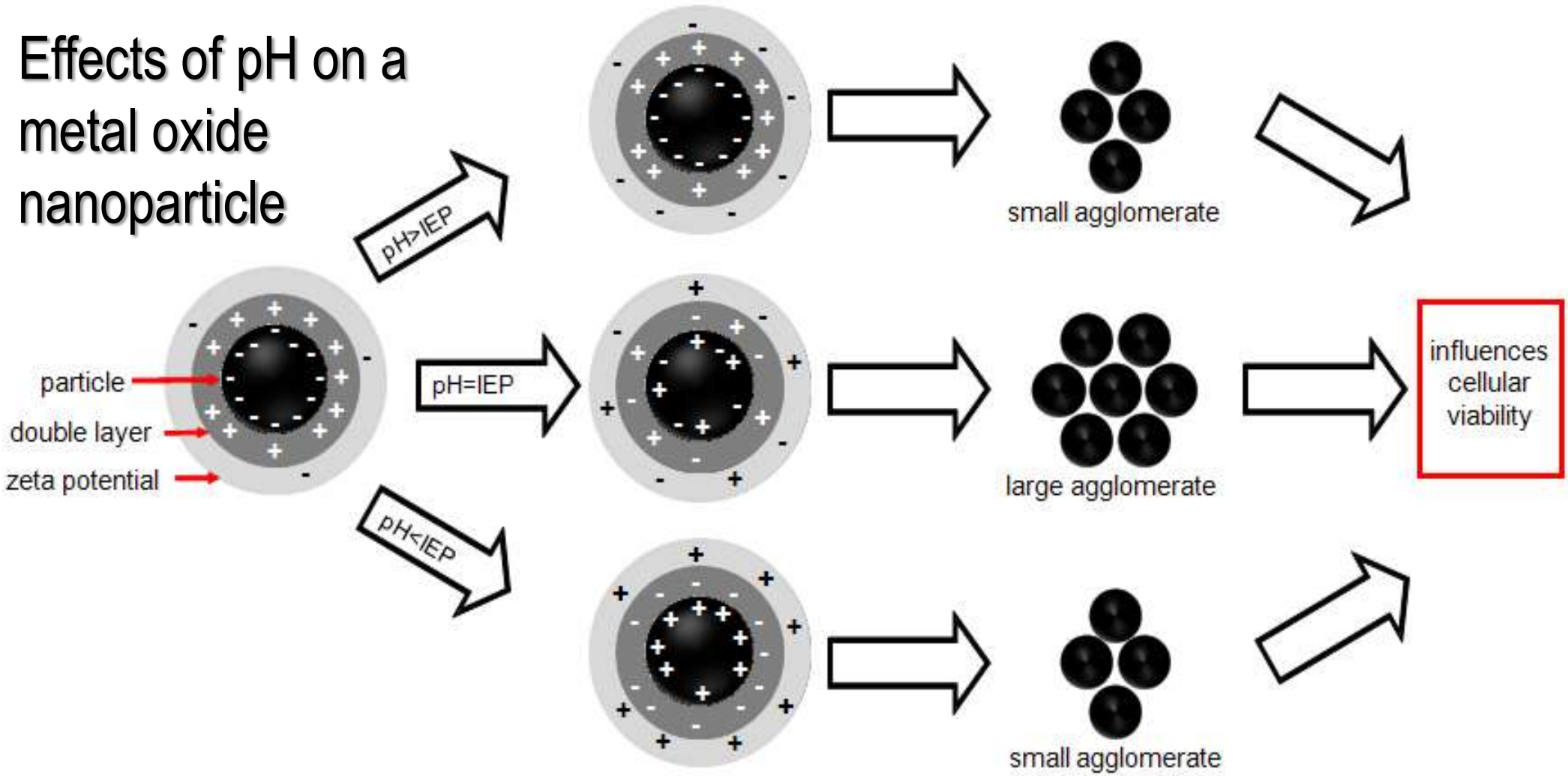
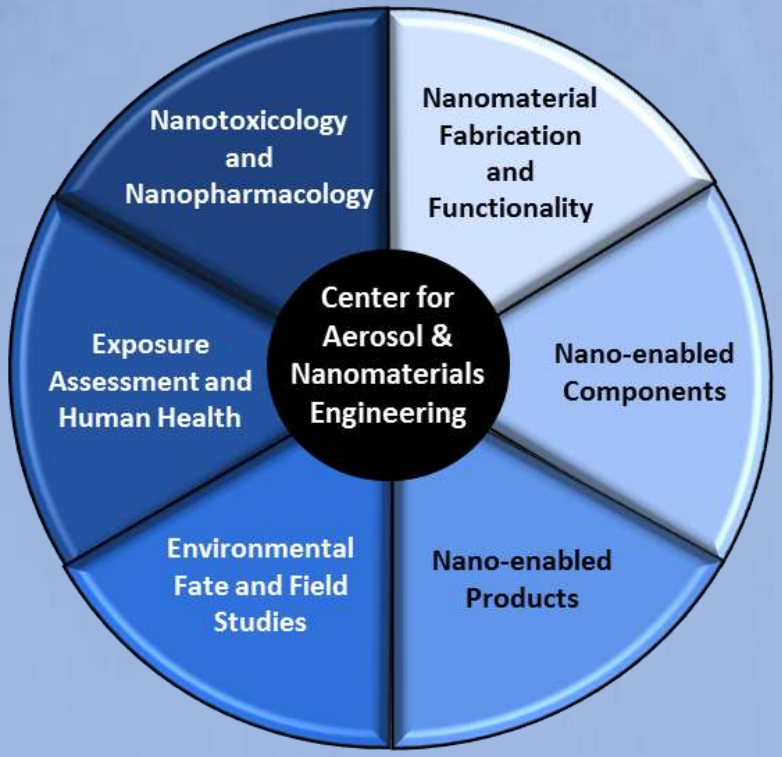
Influence of Zeta Potential



Berg JM, Romoser A, Banerjee N, Zebda R, **Sayes CM**; (2009) *Nanotoxicology*, 3(4): 276–283.

Nanotechnology at RTI International



- Offering a comprehensive toolbox enabling applied nanomaterial R&D
- Providing solutions for clients in commercial, academic and government sectors
- Demonstrated capability to move from concept to commercial products
- Global leader in nanomaterial and aerosol EHS and standards development

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